Realtime Achilles Ultrasound Thompson (RAUT) test in the evaluation and diagnosis of acute Achilles tendon ruptures

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NO CONFLICT TO DISCLOSE

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My disclosure is in the Final AOFAS Mobile App.

I have no potential conflicts with this presentation
Introduction: Achilles Dx Background

• The acute complete Achilles tendon rupture is the 2nd most common ruptured tendon seen in orthopaedics¹

• An acute Achilles rupture often leads to a prompt diagnosis by the clinician when the hallmark features of a rupture are present. Currently, The American Academy of Orthopaedic Surgery (AAOS) clinical practice guideline recommends the presence of two of four clinical stigmata of an acute rupture to make the diagnosis²

• Several studies report up to a 25% missed diagnosis on initial presentation of an acute Achilles tendon rupture³-⁶

• Could there be an easier way for the community orthopaedist to image the Achilles and obtain the diagnosis in an office or ambulatory care setting with common imaging tools?
The Realtime Achilles Ultrasound Thompson (RAUT) Test: A novel realtime ultrasound examination

- During RAUT test, the US probe is placed in the same position as in static US
- A Thompson test is then performed; Repetitive squeezes were performed over 15 seconds; This can be observed or recorded (for testing purposes)

- While observing the excursion of an intact Achilles with US Thompson testing, two observations may be made
  - 1. Quadrilateral morphology of the intact tendon
  - 2. The Shifting Sands sign; Apparent counter excursion (opposite directed motion) between the deep flexors and the Achilles with a crisp endpoint

- Absence of these two signs indicates an acute tendon rupture
Introduction: Ultrasound and Hypothesis

- Ultrasound has long been favored as a first-line imaging diagnostic modality due to the ease of use, cost effectiveness, low risk and for its ability to diagnose soft tissue disturbances not shielded by bone\(^7\)-\(^{10}\).
- The superficial anatomy of the Achilles tendon lends itself well to US imaging \(^9\),\(^{11}\).
- Current use of Achilles static ultrasound has focused primarily on detection of a void at the tear site or “dynamic” studies which aim to quantify the tendinous gap between resting and plantar flexed ankle states for determining indications for surgical repair \(^8\),\(^9\),\(^{12}\).

- We propose in place of standard static ultrasonography, performing a Realtime Achilles Ultrasound Thompson (RAUT) test will allow the visualization of Achilles tendon excursion and morphologic changes characteristic of an intact tendon. Lack of such changes aides in the diagnosis of a ruptured tendon.
Materials and Methods: RAUT Test Vs. Static US (current standard)

• January 1, 2013-July 31, 2014, all patients presenting to the senior surgeons with the presumptive diagnosis of an acute Achilles tendon rupture by other modalities (clinical or MRI) were evaluated on day of surgery with RAUT test screening in the pre-operative area

• All 22 pts that were evaluated went on to have operatively confirmed Achilles tendon ruptures

• Inclusion criteria included presentation for surgery less than 21 days from injury and to be medically fit for surgery

• Exclusions for participation were known or suspect chronic Achilles rupture and poor quality of either static or RAUT recordings

• Both the operatively confirmed ruptured limb and its matching contralateral control limb underwent RAUT testing and traditional static ultrasound imaging

• We then compared sensitivity and specificity between RAUT test recordings and static ultrasound images and interobserver reliability (multiple grader kappa analysis) by producing a blinded test of RAUT recordings and static images

• The test was shown to n=47 orthopaedic residents containing a mixture of ruptured and control Achilles after a brief tutorial
Static ultrasound testing: An image producing test

• Patients were placed in the prone position, with the ankle extending off the end of a gurney
• An Sonosite 13-6MHz ultrasound probe with acoustic-conductive jelly was placed 4 cm superior to the calcaneal tuberosity directly posterior
• Static images were captured with the ankle in neutral resting position
• For static images disruption of the linear, dark, fibrillar striated band of the Achilles, and often replaced with dense hypoechoic or anechoic fluid collections, represented a rupture
Achilles and posterior compartment shape changes during RAUT testing

- Characteristics of an intact Achilles tendon during RAUT recording. A. Quadrilateral morphology is seen when a square unit of tendon differentially excurses and flattens in its PA diameter during Thompson testing. B. Shifting Sands sign is observed as the perceived counter excursion of the Achilles tendon and the deep compartment flexor mass.
## Results: RAUT testing Vs. Static US

<table>
<thead>
<tr>
<th></th>
<th>Static Imaging</th>
<th>RAUT Video Recordings</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sensitivity</strong></td>
<td>76.79% (95% CI 74.07-79.31 %)</td>
<td>87.23% (95% CI 85.01-89.18 %)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td><strong>Specificity</strong></td>
<td>74.76% (95% CI 71.97-77.36 %)</td>
<td>81.14% (95% CI 78.59-83.45 %)</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td><strong>Positive Predictive Value</strong></td>
<td>75.26% (95% CI 72.52-77.82 %)</td>
<td>82.22% (95% CI 79.80-84.42 %)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td><strong>Negative Predictive Value</strong></td>
<td>76.31% (95% CI 73.53-78.87 %)</td>
<td>86.41% (95% CI 85.05-88.47 %)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
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**Table 1.** Statistical summary: Realtime Achilles Ultrasound Test (RAUT) are videos of tendon excursion or lack of excursion during Thompson testing on control and operatively confirmed ruptured legs. Static images were captured at 4cm above Achilles insertion.

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</thead>
<tbody>
<tr>
<td><strong>Kappa Interobserver reliability</strong></td>
<td>k= 0.46, 95% CI 0.45-0.47</td>
<td>k= 0.62, 95% CI 0.61-0.64</td>
</tr>
<tr>
<td><strong>Statistical interpretation (Landis and Koch, 1977)</strong></td>
<td>Moderate agreement</td>
<td>Substantial agreement</td>
</tr>
</tbody>
</table>

**Table 2.** Results of Kappa inter-observer agreement for test takers in closed session. n=47 test takers (88 questions per test taker), 4136 unique observations made.
Discussion and Conclusion:

- RAUT testing was superior to our novice audience’s interpretation of static images.
- Quadrilateral morphology sign seen on intact tendon may be related to the differential excursion of the Achilles in the superficial to deep plane resulting from unique contributions of the GCN and soleus.
- Apparent counter excursion between Achilles and deep flexors (shifting sands sign) functions through unknown mechanism; however a reliable sign for an intact Achilles tendon.
- Strengths include a sufficiently powered study (n=22, for a perceived beta of 0.20), operatively confirmed ruptures, contralateral limb controls, prospective, strict single-sided blinding with testing in a controlled environment, test taking audience with minimal US experience (naïve audience).
- Weaknesses are no patient demographical data collected.
- RAUT testing technique is highly sensitive and specific test for the evaluation and diagnosis of the rupture of the Achilles tendon. It’s a safe and effective method, which is cost efficient, rapid, and widely available for diagnosing acute Achilles tendon tears. It offers easier recognition of a complete tear via lack of clear characteristic changes observed in tendon morphology and excursion seen in intact tendons when compared to static ultrasound images and can be an effective adjunct to the clinical exam.
Citations: